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(54) Title of the Invention: Temperature-sensitive sensor

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SPECIFICATION

1. Title of the Invention

Temperature-sensitive sensor

2. Scope of the Patent Claims

1. Temperature-sensitive sensor in which a substrate is provided on a heat sink, a plurality of temperature-sensitive bodies are provided on said substrate, and the thermal conductivities of the substrate portions which are provided with the temperature-sensitive bodies are different.

2. Temperature-sensitive sensor according to Claim 1, in which the substrate comprises a quartz glass plate and a silicon plate which forms an insulating layer on the surface, and both of said plates are arranged side by side on the heat sink.

3. Temperature-sensitive sensor according to Claim 1 or 2, in which the portions of differing thermal conductivity have a ratio of thermal conductivity of 10 to 200.

4. Temperature-sensitive sensor according to any of Claims 1 to 3, in which the temperature-sensitive bodies are thin-film resistors formed from at least one of silver or platinum.

3. Detailed Description of the Invention

[Field of Industrial Application]

The present invention relates to a temperature-sensitive sensor, and in particular to a temperature-sensitive sensor which is suitable for detecting sudden changes in temperature.

[Prior Art Technology]

Devices exist for detecting sudden rises in temperature (sudden changes in temperature) which occur during

fires and abnormalities in production machines, and generating a warning. A temperature-sensitive sensor for capturing the sudden rise in temperature is used in devices of this kind.

Conventionally, temperature-sensitive sensors of this type, comprising a diaphragm which has small holes and an electrical contact point of which the opening and closing action is caused by the movement of said diaphragm, are provided for practical use. When there is a gentle rise in temperature, even if the vapour inside the diaphragm expands due to swelling, the vapour in the portion which has expanded is successively released to the outside via the small holes, and the diaphragm does not swell greatly. However, when there is a sudden rise in temperature, all of the vapour which has expanded cannot be immediately released to the outside from the small holes, and therefore the diaphragm swells greatly, and the connection state of the electrical contact point is switched in line with this movement. It is possible to detect the fact that there has been a sudden rise in temperature by means of the switching of the connection state of said electrical contact point.

There are also temperature-sensitive sensors which employ thermistors. These temperature-sensitive sensors have a configuration provided with thermistors which are respectively and separately attached to two projecting rod-shaped bodies, and when there is a sudden change in temperature a difference arises in the resistance value of both thermistors. In devices which use this temperature-sensitive sensor, the output difference of both thermistors is monitored, and although the output difference of both thermistors is only slight when there is a gentle rise in temperature, the output difference of both thermistors is significant when there is a sudden rise in temperature, and therefore it is possible to detect the fact that

there has been a sudden rise in temperature by capturing this.

[Problem to be Resolved by the Invention]

However, there are problems with temperature-sensitive sensors which employ the abovementioned diaphragm in that it is difficult to make them compact, they are ill-suited to corrosive atmospheres, and in addition their reliability is diminished as the small holes are liable to clog in very dusty atmospheres.

On the other hand, there are problems with temperature-sensitive sensors which employ thermistors in that it is difficult to arrange the thermistors to show the difference in the temperature rise between the thermistors, and the thermistors are fixed to the projecting rod-shaped bodies, among other things, and therefore there are also limits to compactness, mechanical strength is also lower, which diminishes reliability.

The object of the present invention, in view of the abovementioned situation, is to provide a temperature-sensitive sensor which is suited to compactness, which has a structure with high reliability and which makes it possible to accurately detect sudden changes in temperature.

[Means of Resolving the Problems]

In order to resolve the problem described above, the temperature-sensitive sensor according to Claims 1 to 4 has a configuration in which a substrate is provided on a heat sink, a plurality of temperature-sensitive bodies are provided on said substrate, and the thermal conductivities of the substrate portions which are provided with the temperature-sensitive bodies are different.

Examples of a substrate provided with temperature-sensitive bodies include configurations comprising a quartz glass plate (low thermal conductivity) and a silicon plate (high thermal conductivity) which forms an insulating layer on the surface, and both of said plates are arranged side by side on the heat sink, as in Claim 2.

There is a laminated film or the like on the insulating layer in which only a suitable number of silicon oxide films, silicon nitride films or silicon oxide and silicon nitride films are layered to give a thickness of approximately 1 μm. The thickness of the substrate overall is normally of the order of 100 μm to 1 mm. As described above, where there are a plurality of substrate parts, such as quartz glass plates and silicon plates, the thickness of each single substrate is often made to be almost the same, but it is not necessarily essential to use the same thickness.

The ratio of thermal conductivity (greater thermal conductivity/smaller thermal conductivity) of the portions of differing thermal conductivity is normally of the order of 10 to 200, as in Claim 3.

Furthermore, thin-film resistors formed from at least one of silver or platinum are ideal as the temperature-sensitive bodies, as in Claim 4.

It should be noted that the heat sink is in most cases made of a normal metal material which has good heat conductivity.

[Action]

The temperature-sensitive sensor of the present invention is provided with respective temperature-sensitive bodies on portions of the substrate which have differing thermal conductivities. The portions of the substrate which have high thermal conductivity

readily conduct heat with the heat sink (high heat flow), while the portions of the substrate which have low thermal conductivity sparingly conduct heat with the heat sink (low heat flow). Consequently, when there is a sudden change in the temperature in the atmosphere in which detection is taking place, it is possible for the change in temperature to be absorbed by the heat sink in the portions of the substrate with high thermal conductivity, and there is no immediate change in temperature in the temperature-sensitive bodies of these portions of the substrate. On the other hand, it is possible for the change in temperature not to be transferred to the heat sink in the portions of the substrate with low thermal conductivity, and for there to be a quick action on the temperature-sensitive bodies; the temperature-sensitive bodies of these portions of the substrate are sensitive to sudden changes in temperature and are moved in response to them. Accordingly, when there is a sudden change in temperature in the atmosphere in which detection is taking place, there is a large temperature difference between the respective temperature-sensitive bodies, and this leads to a significant signal difference arising between the outputs of the temperature-sensitive bodies. Of course, in the case where the temperature in the atmosphere in which detection is taking place changes gently, there is no significant temperature difference between the two groups of temperature-sensitive bodies, and therefore the signal difference between the outputs of the temperature-sensitive bodies is only slight. That is to say, if the signal difference between the outputs of the temperature-sensitive bodies is monitored, a large signal is made visible when there is a sudden change in temperature in the atmosphere in which detection is taking place, and therefore, if this is detected, it is possible to accurately capture sudden changes in temperature in the atmosphere in which detection is taking place.

Although there is a temperature difference between the temperature-sensitive bodies when there has been a sudden temperature change, the present invention relies on differences in the thermal conductivity of portions of the substrate, rather than on an arrangement of temperature-sensitive bodies as in conventional temperature-sensitive sensors which employ thermistors, and therefore there is no need to consider the arrangement of the temperature-sensitive bodies.

This being so, a structure comprising a heat sink to which the substrate is firmly fixed is a structure with a high level of reliability, and it is suitable for compactness. For example, if the temperature-sensitive parts are made as thin-film resistors for measuring temperature which are formed on the surface of the substrate, sufficient compactness can be envisaged.

Furthermore, a substrate configuration comprising a quartz glass plate and a silicon plate which forms an insulating layer on the surface brings about improved resistance to environmental factors, and furthermore temperature-sensitive bodies comprising resistors made of silver or gold material also by their nature bring about improved resistance to environmental factors.

When the temperature-sensitive bodies are thin-film resistors which are formed using at least one of gold or platinum, it is possible for the signal output to achieve a good level of directness from the temperature-sensitive bodies in response to changes in temperature, and therefore the signals are easily processed.

[Exemplary Embodiment]

One exemplary embodiment of the temperature-sensitive sensor pertaining to the present invention will be

described in detail below with reference to the appended figures.

Figure 1 shows the configuration of a temperature-sensitive sensor pertaining to an exemplary embodiment of the present invention.

A temperature-sensitive sensor 1 is provided with a heat sink 2 and a substrate 4 on the surface of which temperature-measuring thin-film resistors (temperature-sensitive bodies) 3, 3′ are formed. The substrate 4 is configured from two plates: quartz glass plate 4′ and silicon plate 4′′, and both of the plates 4′, 4′′ are arranged side by side on the heat sink 2. As can be seen in Figure 2, the thin-film resistor 3 is formed on the surface of the quartz glass plate 4′, and the thin-film resistor 3′ is formed on the surface of the silicon plate 4′′.

The whole of the quartz glass plate 4′ can be made from quartz glass, while on the other hand a silicon oxide layer 4′′a of thickness 1 μm is formed on the surface of the silicon plate 4′′, but otherwise this is a silicon layer 4′′b. The silicon oxide layer 4′′a can be formed by means of a thermal oxidation method, a sputtering deposition method or a vacuum deposition method or the like.

The thin-film resistors 3, 3′ are formed on the quartz glass plate 4′ and the silicon oxide layer 4′′a of the silicon plate 4′′ by means of patterning using wet etching or dry etching, after a thin film of platinum or gold has been formed by a sputtering deposition method or a vacuum deposition method. It should be noted that after the thin-film resistors 3, 3′ have been formed, they are covered by an electrically-insulating protective film 6 so as not to be affected by condensation (the protective film 6 has been omitted from Figure 2).

The quartz glass plate 4′ and the silicon plate 4′′ on which the thin-film resistors and the protective film have been formed are bonded to the heat sink 2. It should be noted that a lead wire 8 is used for signal output.

The thermal conductivity of the quartz glass plate 4′ which constitutes the substrate portion provided with the thin-film resistor 3 is approximately 0.0138 W/cm °C, and the thermal conductivity of the silicon plate 4′′ with the attached silicon oxide layer which constitutes the substrate portion provided with the thin-film resistor 3′ is approximately 1.48 W/cm °C. In this way, the thermal conductivities of the substrate portions which are provided with the thin-film resistors 3, 3′ differ greatly, with one being approximately 100 times the other.

The present invention is not limited to the exemplary embodiment described above.

For example, as with the temperature-sensitive sensor 1′ shown in Figure 3, a configuration may be adopted in which the substrate 14, on the surface of which the thin-film resistors 3, 3′ are formed, comprises two insulating plates 14′, 14′′, the whole of either of which may be made from a different type of insulating material, and both of the plates 14′, 14′′ are arranged side by side on the heat sink 2 and have a thermal conductivity ratio of at least 10. A description of the rest of the configuration will be omitted because it is the same as that of the temperature-sensitive sensor of Figure 1.

In addition, as with the temperature-sensitive sensor 1′′ shown in Figure 4, a configuration may be adopted in which the substrate 24, on the surface of which the thin-film resistors 3, 3′ are formed, has a low

thermal-conductivity plate 24′ inside a high thermal-conductivity plate 24′′. In this case, the high thermal-conductivity plate 24′′ may be the silicon plate which is provided on its surface with an insulating layer, or the whole of it may comprise an insulating material with comparatively good thermal conductivity.

Accordingly, with the temperature-sensitive sensor 1′′, the thin-film resistor 3 is provided on the portion T of the substrate with low thermal conductivity, and the thin-film resistor 3′ is provided on the portion T′ of the substrate with high thermal conductivity. A description of the rest of the configuration will be omitted because it is the same as that of the temperature-sensitive sensor of Figure 1. It should be noted that both of the plates 24′, 24′′ preferably have a thermal conductivity ratio of at least 10.

[Effect of the Invention]

As described above, the temperature-sensitive sensor according to Claims 1 to 3 has a configuration in which a plurality of temperature-sensitive bodies are provided on a substrate on a heat sink, and the thermal conductivities of the substrate portions which are provided with the temperature-sensitive bodies are different, and therefore this is an outstanding sensor which is suitable for compactness, which has a structure with a high level of reliability, and which enables accurate detection of sudden changes in temperature.

In addition, the temperature-sensitive sensor according to Claim 2 has a substrate configuration comprising a quartz glass plate and a silicon plate which forms an insulating layer on the surface, and therefore it offers outstanding resistance to environmental factors.

In addition, the substrate portions of differing thermal conductivity of the temperature-sensitive sensor according to Claim 3 have a ratio of thermal conductivity of 10 to 200, and therefore they can capture sudden changes in temperature more accurately.

In addition, the temperature-sensitive bodies of the temperature-sensitive sensor according to Claim 4 are thin-film resistors formed using at least one of gold or platinum, and therefore they offer outstanding resistance to environmental factors, and, moreover, it is possible for the signal output to achieve a good level of directness in response to changes in temperature, and therefore the signals are easily processed.

4. Brief Description of the Figures

Figure 1 is a cross-sectional view representing one exemplary embodiment of the temperature-sensitive sensor pertaining to the present invention; Figure 2 is a plane view representing the same temperature-sensitive sensor; and Figure 3 and Figure 4 are respectively cross-sectional views representing other exemplary embodiments of the temperature-sensitive sensor according to the present invention.

1, 1′, 1′′...temperature-sensitive sensor; 2...heat sink; 3, 3′...thin-film resistor (temperature-sensitive body); 4, 14, 24...substrate.

Representative, Patent Attorney Takehiko MATSUMOTO

Figure 1 Figure 3

Figure 2 Figure 4

PROCEDURAL AMENDMENT

9 November 1990

[seal]

To: Commissioner, Patent Office

1. Indication of Case

Patent Application H2-223532

2. Title of the Invention

Temperature-sensitive sensor

3. Amending Party

Relationship to Case: Patent Applicant

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[seal]

5. Increase in Number of Paragraphs due to Amendment

none

[seal of Japanese Patent Office]

6. Subject of Amendment

Specification

7. Content of Amendment

(1) The whole of the scope of the patent claims in the specification is amended as follows:

-Notes-

"**1.** Temperature-sensitive sensor in which a substrate is provided on a heat sink, a plurality of temperature-sensitive bodies are provided on said substrate, and the thermal conductivities of the substrate portions which are provided with the temperature-sensitive bodies are different.

2. Temperature-sensitive sensor according to Claim 1, in which the substrate comprises a quartz glass plate and a silicon plate which forms an insulating layer on the surface, and both of said plates are arranged side by side on the heat sink.

3. Temperature-sensitive sensor according to Claim 1 or 2, in which the portions of differing thermal conductivity have a ratio of thermal conductivity of 10 to 200.

4. Temperature-sensitive sensor according to any of Claims 1 to 3, in which the temperature-sensitive bodies are thin-film resistors formed from at least one of gold or platinum."

(2) "white" which appears on line 11 of block 5 of the specification is deleted.

(3) "not to be transferred" on line 8 of block 6 is amended to "not to be readily transferred".